REMARKS
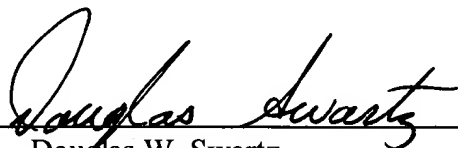
Attached hereto is a marked up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "**Version With Markings to Show Changes Made**."

Amendments to the Specification are based substantially on amendments made in the parent application.

Applicant respectfully submits that the amendments to the above claims are made to clarify further the claimed subject matter and are unrelated to patentability.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Paragraph beginning at page 4, line 1 has been amended as follows:

In another technique, the interfering signals are selectively nulled by beam steering. Classical [beamsteering]beam steering, however, does not provide, without additional improvements, the required angular resolution for densely populated communications environments.

Paragraph beginning at page 4, line 20 has been amended as follows:

These and other objectives are addressed by the spread spectrum system architecture of the present invention. In one embodiment, the system includes: (i) an antenna adapted to receive a signal that is decomposable into first and second signal segments, [a]the first signal segment of the signal being attributable to a first source and [a]the second signal segment of the signal being attributable to a source other than the first source; and (ii) an oblique projecting device, in communication with the antenna, for determining the first signal segment. The signal can be any structured signal, such as a spread spectrum signal, that is decomposable into at least a first signal segment and a second signal segment. A "structured signal" is a signal that has known values or is created as a combination of signals of known values.

Paragraph beginning at page 5, line 17 has been amended as follows:

For spread spectrum applications where noise characteristics are quantifiable, oblique projection is preferably performed utilizing the following algorithm:

$$(y^T (I-S (S^TS)^{-1}S^T) H(H^T(I-S(S^TS)^{-1}S^T)H)^{-1}H^T(I-S(S^TS)^{-1}S^T)y)/\sigma^2$$

where y corresponds to a selected portion of the spread spectrum signal, H corresponds to an interference code matrix for the first signal segment (which defines a first space including the first signal), S corresponds to the interference code matrices for signals of all of the other sources (users) in the selected portion of the spread spectrum signal (which defines a second space including the signals of the other sources), ^{T} corresponds to the transpose operation and σ^2 corresponds to the variance of the magnitude of the noise in the selected portion of the spread spectrum signal. Where noise is present, a substantial portion of the noise may be generated by the receiver. As will be appreciated, the oblique projection can be done using other suitable algorithms.

Paragraph beginning at page 6, line 13 has been amended as follows:

(b)   a projection [operator]filter for determining the first CDMA signal segment, the first CDMA signal segment spanning a first signal space, the projection [operator]filter being in communication with the one or more antennas and determining the first CDMA signal segment by projecting a signal space spanned by the signal onto the first signal space. The first signal space is

orthogonal to an interference space that corresponds to an interference code matrix for the second CDMA signal segment and/or second emitter.

Paragraph beginning on page 10, line 10 has been amended as follows:

Fig. 6 depicts the three dimensional correlation surface [employed by the threshold detecting device]output by the bank of projection filters in the correlating device of Fig. 1;

Paragraph beginning on page 10, line 14 has been amended as follows:

Fig. 9 depicts a correlation surface defined by the correlation function output by the bank of projection filters in the demodulating device of Fig. 1;

Paragraph beginning on page 11, line 12 has been amended as follows:

An overview of the current architecture for detecting signals from an ith user in a CDMA system is illustrated in Fig. 1. The architecture employs a single antenna for receiving CDMA signals. The system includes the antenna 50 adapted to receive the spread spectrum signal and generate an output signal 54, filters 58 and 60 for filtering the in-phase ("I") and quadrature ("Q") channels to form filtered channel signals 62 and 66, a correlating device 70 for providing a hypothetical correlation function characterizing a filtered signal segment, which may be multipath signal segment(s) of a source signal (hereinafter collectively referred to as a "signal segment"), transmitted by a selected user, a first threshold [timing]detecting device 74 for generating timing information defining the temporal relationship among a plurality of peaks defined by the hypothetical correlation function, a timing reconciliation device 78 for determining a reference time based on the timing information, a RAKE processor 82 for aligning multipath signal segments for each selected user in time and phase and outputting an aligned signal for the selected user, a demodulating device 86 for demodulating aligned signals transmitted by each selected user into correlation functions and, finally, a second threshold detecting device 90 for converting the correlation functions into digital information. As will be appreciated, a system configured for radar or GPS applications may not include some of these components, such as the filters 58 and 60, and the conversion from analog to digital may be performed either at RF or IF.

Paragraph beginning on page 13, line 20 has been amended as follows:

The hypothetical projection operators are generated using the algorithm:
$$(I-S(S^TS)^{-1}S^T) \; H \; (H^T(I-S(S^TS)^{-1}S^T) \; H)^{-1}H^T(I-S \; (S^TS)^{-1}S^T)$$
where H corresponds to an interference code matrix for the selected signal segment, S corresponds to the interference code matrices for all of the other signal segments in the selected filtered signal portion, I is the identity matrix, and ^{T} corresponds to the transpose operation. The variables H and S depend upon the interference codes determined by the user code generator 94. Accordingly, H and S depend, respectively, upon the transmit time for the selected signal segment, and the transmit times

of all of the other signal segments in the selected filtered signal portion. Because the data is indexed by the receive time, S is also a function of the receive time.

Paragraph beginning at page 14, line 11 has been amended as follows:

Next, the bank of projection filters 102, with one filter corresponding to each trial time and/or candidate symbol (i.e., to each hypothetical projection operator), provide a set of filter outputs (i.e., hypothetical correlation functions) to be threshold detected by the first threshold detecting device 74. Each of the bank of projection filters correlates 130 a plurality of multipath signal segments for a given trial time and/or candidate symbol. The projection filters 102 extract an estimated signal segment attributable to a given user from each selected filtered signal portion while simultaneously nulling out the other signal segments from other users.

Paragraph beginning at page 18, line 1 has been amended as follows:

The first threshold detecting device 74 uses the hypothetical correlation functions for each user that are outputted by the bank of projection filters 102 to determine the temporal locations of the various multipath signal segments in the hypothetical correlation function. Due to multipath delays, each hypothetical correlation function can have multiple peaks as shown in Fig. 6. As set forth above, the various peaks in the correlation surface can be isolated using known mathematical techniques. Using techniques known in the art and the temporal location of the peaks (or timing information) output by the first threshold detecting device 74, the timing reconciliation device 78 determines a reference time for the RAKE processor 82. The reference time is based upon the receive times of the various peaks located by the first threshold detecting device 74. The reference time is used by the RAKE processor 82 as the time to which all of the signal segments for a given user are aligned.

Paragraph beginning at page 18, line 12 has been amended as follows:

The RAKE processor 82 based on the timing information, the peak amplitudes of the hypothetical correlation function(s) detected by the first threshold detecting device, and the filtered signals 62 and[,] 66 scales and aligns (in time and phase) the various multipath signal segments transmitted by a given user and then sums the aligned signal segments for that user. The RAKE processor 82 can be a maximal SNR combiner.

Paragraph beginning at page 19, line 5 has been amended as follows:

Referring again to [Fig. 7]Figs. 1 and 7 (which illustrates the operation of RAKE processor 82), the RAKE processor 82 first sums 178 the outputs of the various antenna elements, shifts 182 the various sequences in the outputs by the amounts of the multipath delays between the corresponding multipath signal segments of a selected signal segment, so that all multipath signal segments are perfectly aligned. It then weights each shifted multipath signal segment by the amplitude of the

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correlation function corresponding to that segment and sums 186 the weighted components to produce the aligned signal $y_R(k)$. The aligned signal $y_R(k)$ is then detected 187 to form digital output 188.

Paragraph beginning at page 19, line 9 has been amended as follows:

The demodulating device 86 correlates the "RAKED" sequence, $y_R(k)$ with the appropriate replicated segment of the coded signal in the filter bank 102 to produce the correct correlation function for detection by a second threshold detecting device 90. Referring to [Fig. 8]Figs. 1 and 8 (which illustrates the components of demodulating device 86), the demodulating device 86, like the correlating device 70 includes a user code generator 200, a projection builder 204, and a bank of projection filters 208. The projection builder 204 and bank of projection filters 208 use the equations set forth above to provide projection operators and correlation functions. Unlike the correlating device 70 which provides for a series of hypothetical projection operators and correlation functions based on the trial time, receive time, and candidate symbol for each multipath signal segment, the demodulating device 86 uses the "RAKED" sequence which has only a single aligned signal segment rather than a plurality of independent multipath signal segments. Accordingly, the demodulating device 86 is able to reliably estimate the actual transmit time for the source signal and therefore requires considerably less processing to determine a correlation function than the correlating device 70.

Paragraph beginning at page 21, line 17 has been amended as follows:

Fig. 10 depicts a multiple antenna system according to another embodiment of the present invention. Each antenna 50a-n is connected to filters 250a-n and 254a-n, correlating device 258a-n, threshold detecting device 262a-n, and a RAKE processor 266a-n. The threshold detecting devices 262a-n for all of the antennas 50a-n are connected to a common timing reconciliation device 270, which in turn is connected to all of the RAKE processors 266a-n. In this manner, all of the RAKE processing for all of the filtered signals is performed relative to a common reference time. The combined output of the RAKE processors 266a-n is provided to a common demodulating device 274 for determination of the correlation functions and summing of the signal portions received by all of the antennas that are attributable to a selected user. The system in effect "phases" the output of each antenna in order to maximize the SNR.

Paragraph beginning at page 24, line 9 has been amended as follows:

The outputs from [all of] the other RAKE processors 266a-n are combined 342 to form[ed] a combined output 343.

IN THE CLAIMS:

Claims 4, 11, 13-17, 19,29, 39-40, 42-45, and 47 have been amended as follows:

4. (Once Amended) The system of Claim 3, [including]further comprising a plurality of RAKE processors corresponding with the plurality of projecting means, wherein each of the plurality of projecting means produces a respective projecting means output which is received as a RAKE processor input by each of the plurality of projecting means' corresponding RAKE processor, the respective output of each of the plurality of projecting means being delayed relative to one another, each of the plurality of RAKE processors being adapted to align and scale its respective input to produce a compensated output.

11. (Once Amended) A system for receiving a signal, comprising:
an antenna adapted to receive a signal and adapted to generate an output signal, the output signal being decomposable into:
(i) a first CDMA signal portion attributable to a first source, and
(ii) at least one second CDMA signal portion, the at least one second CDMA signal portion being attributable to at least one second source; and,
a projection [operator]filter in communication with the antenna for determining the first CDMA signal portion of the output signal, the projection [operator]filter being in communication with the antenna and determining the first CDMA signal portion of the output signal by projecting a signal space spanned by the output signal onto a first signal space that corresponds to the first CDMA signal portion, wherein the first signal space is orthogonal to an interference space that corresponds to one or more interference code matrixes corresponding to the at least one second CDMA signal portion.

13. (Once Amended) The system of Claim 12, [wherein the]further comprising a projection [operator]builder operable to determine[s] a projection operator corresponding to the first CMA signal portion by the following equation:
$$(y^T(I-S(S^TS)^{-1}S^T)H(H^T(I-S(S^TS)^{-1}S^T)H)^{-1}H^T(I-S(S^TS)^{-1}S^T)y)/\sigma^2$$
wherein y corresponds to the output signal, H is related to an interference code matrix of the first source, S is related to an interference code matrix of at least a second source, ^{T} denotes the transpose operation, I denotes the identity matrix, and σ^2 corresponds to the variance of the magnitude of the noise portion.

14. (Once Amended) The system of Claim 12, further including a plurality of projection [operators]filters corresponding to a plurality of antennas and being in communication therewith, each of the plurality of projection [operators]filters being adapted to determine a respective first CDMA signal portion of a corresponding portion of the signal received by each of the plurality of antennas and determine the respective first CDMA signal portion of the signal using the equation of Claim 13.

15. (Once Amended) The system of Claim 14, further including a plurality of RAKE processors in communication with a corresponding one of the plurality of projection

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[operators]filters, wherein each of the plurality of projection [operators]filters produces a corresponding projection [operator]filter output which is received as a RAKE processor input by its corresponding RAKE processor, the corresponding projection [operator]filter output of each of the plurality of projection [operators]filters being delayed relative to one another, each of the plurality of RAKE processors being adapted to align and scale their respective inputs to produce a corresponding compensated output.

16. (Once Amended) The system of Claim 15, wherein the corresponding compensated output of each of the plurality of RAKE processors is delivered to a second projection [operator]filter in communication therewith for determining a refined first CDMA signal portion of each of the compensated outputs [by the equation of Claim 13].

17. (Once Amended) The system of Claim 12, wherein the first CDMA signal portion comprises a plurality of multipath signal segments and the projection [operator]filter outputs a correlation function having a plurality of peaks corresponding to the plurality of multipath signal segments, and further comprising:
a threshold detector, in communication with the projection [operator]filter, for generating timing information defining a temporal relationship among the plurality of peaks.

19. (Once Amended) The system of Claim 18, further comprising:
one or more RAKE processors, in communication with the projection [operators]filters and the timing reconciliation device, for aligning the plurality of multipath signal segments in at least one of time and phase based on the magnitudes of the plurality of multipath signal segments and the reference time to form an aligned first CDMA signal.

29. (Once Amended) The method of Claim 20, [wherein the projecting step is]further comprising the step of generating at least one projection operator [performed] according to the equation:

$$(y^T(I-S(S^TS)^{-1}S^T)H(H^T(I-S(S^TS)^{-1}S^T)H)^{-1}H^T(I-S(S^TS)^{-1}S^T)y)/\sigma,^2$$

where y corresponds to the composite signal, H is related to an interference code matrix of the first emitter, S is related to an interference code matrix of at least a second emitter, ^{T} denotes the transpose operation, I denotes the identity matrix and σ^2 corresponds to the variance of the magnitude of a noise portion of the composite signal.

39. (Once Amended) The method of Claim 29, [wherein the projecting step is performed]further comprising the step of generating a plurality of projection operators according to the equation:

$$(y^T(I-S(S^TS)^{-1}S^T)H(H^T(I-S(S^TS)^{-1}S^T)H)^{-1}H^T(I-S(S^TS)^{-1}S^T)y)/\sigma,^2$$

where y corresponds to the composite signal, H is related to an interference code matrix of the first emitter, S is related to an interference code matrix of at least a second emitter, ^{T} denotes the transpose operation, I denotes the identity matrix and σ^2 corresponds to the variance of the magnitude of a noise portion of the composite signal.

40. (Once Amended) A system for processing an output signal of an antenna, the output signal corresponding to a composite signal, comprising:

at least one projection [operator]filter for determining a parameter of an oblique CDMA projection of an output signal of an antenna, the oblique CDMA projection being attributable to an emitter having an interference code matrix and the at least one [oblique] projection [operator]filter determining a parameter of the oblique CDMA projection by projecting obliquely a signal space spanned by the output signal onto a signal space spanned by the oblique CDMA projection and wherein an interference space corresponds to an interference code matrix corresponding to a second CDMA signal segment in the composite signal and the interference space is orthogonal to CDMA signal space spanned by the oblique CDMA projection.

42. (Once Amended) The system of Claim 40, [including]further comprising a plurality of projection [operators]builders corresponding to a plurality of antennas and being in communication therewith, each of the plurality of projection [operators]builders being adapted to determine a respective oblique CDMA projection of a corresponding portion of a respective composite signal received by each of the plurality of antennas and determine the respective oblique CDMA projection of the corresponding output signal by the equation:

$$(y^T(I-S(S^TS)^{-1}S^T)H(H^T(I-S(S^TS)^{-1}S^T)H)^{-1}H^T(I-S(S^TS^{-1})S^T)y)/\sigma^2$$

where y corresponds to the output signal, H is related to an interference code matrix of the emitter, S is related to an interference code matrix of at least a second emitter, ^{T} denotes the transpose operation, I denotes the identity matrix, and σ^2 corresponds to the variance of the magnitude of a noise portion of the output signal.

43. (Once Amended) The system of Claim 42, wherein the at least one projection filter comprises a plurality of projection filters corresponding to the plurality of antennas and further comprising [including] a plurality of RAKE processors in communication with a corresponding one of the plurality of projection [operators]filters, wherein each of the plurality of projection [operators]filters produces a corresponding projection [operator]filter output which is received as a RAKE processor input by each of the plurality of projection [operator's]filter's corresponding RAKE processor, the corresponding projection [operator]filter output of each of the plurality of projection [operators]filters being delayed relative to one another, each of the plurality of RAKE processors being adapted to align and scale their respective inputs to produce a corresponding compensated output.

44. (Once Amended) The system of Claim 43, wherein the corresponding compensated output of each of the plurality of RAKE processors is delivered to a second projection [operator]filter in communication therewith for determining a refined projection [operator]filter of each of the compensated outputs [by the equation of Claim 40].

      45.   (Once Amended) The system of Claim 40, wherein the oblique CDMA projection comprises a plurality of multipath signal segments and the projection [operator]filter outputs a correlation function having a plurality of peaks corresponding to the plurality of multipath signal segments, and further comprising:

5   a threshold detector, in communication with the projection operator, for generating timing information defining a temporal relationship among the plurality of peaks.

      47.   (Once Amended) The system of Claim 46, further comprising:

      one or more RAKE processors, in communication with the projection [operators]filters and the timing reconciliation device, for aligning the plurality of multipath signal segments in at least one of time and phase based on the magnitudes of the plurality of

5   multipath signal segments and the reference time to form an aligned first signal.

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